



# IMPACT OF RECENT ENVIRONMENTAL CHANGE ON SMALL MAMMALS OF THE RUBY MOUNTAINS: AN 80-YEAR RESURVEY

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## ABSTRACT

Biotic communities in the Great Basin are changing dramatically due to shifting land use, invading alien plants, and climate change. Our study involves comparative resurveys across an 80-year interval to measure changes in the small mammal fauna of the Ruby Mountains. We used historical records (specimens, field notes, and photographs) from a survey conducted during 1927-1929 to reconstruct species assemblages and ecological conditions at 9 localities. During 2006-2008, we made new field surveys to assess changes in community composition and shifts in the elevational distributions of species. Comparison of climate data for the two sampling intervals indicate increases in both precipitation and summer maximum temperature across all elevations, and increased winter minimum temperature at mid to high elevations. At individual localities there have been significant changes in relative abundance or occurrence of small mammal species, some in conjunction with major floristic changes, and others apparently in direct response to climate warming. Along the elevation gradient, there were changes in the proportional abundance of mesic and xeric-adapted species, and upslope range shifts of two mesic-adapted species consistent with predicted responses to climate warming. However, we did not observe upslope range shifts or expansions for any xeric-adapted species. This is inconsistent with a climate-based hypothesis and may reflect the unexpected predominance of habitat changes driven by land use at this broad spatial scale. Across the resurvey interval, small mammal abundance, biomass, and energy use have declined at both local and landscape scales suggesting a major drop in resource availability.

## METHODS

Trapping surveys of small mammals were made using comparable methods at 15 historical and 22 modern localities, including 9 resurvey localities (surveyed during both time periods). Field notes were used to determine trapping effort and to calculate relative abundance and biomass. Species identifications were verified with museum voucher specimens. Historical photographs and field notes were used to assess habitat changes. Weather data for both time intervals were obtained from PRISM Climate Group.

## STUDY AREA

Map of Ruby Mountains showing localities surveyed during historical (1927-1929) and modern (2006-2008) periods.

## SMALL MAMMALS

21 Species (rodents and insectivores)

Habitat groups:  
8 mesic-adapted species  
7 xeric-adapted species; 6 generalists

Diet Groups  
4 granivores; 4 herbivores  
5 insectivores; 8 omnivores



## CLIMATE TRENDS

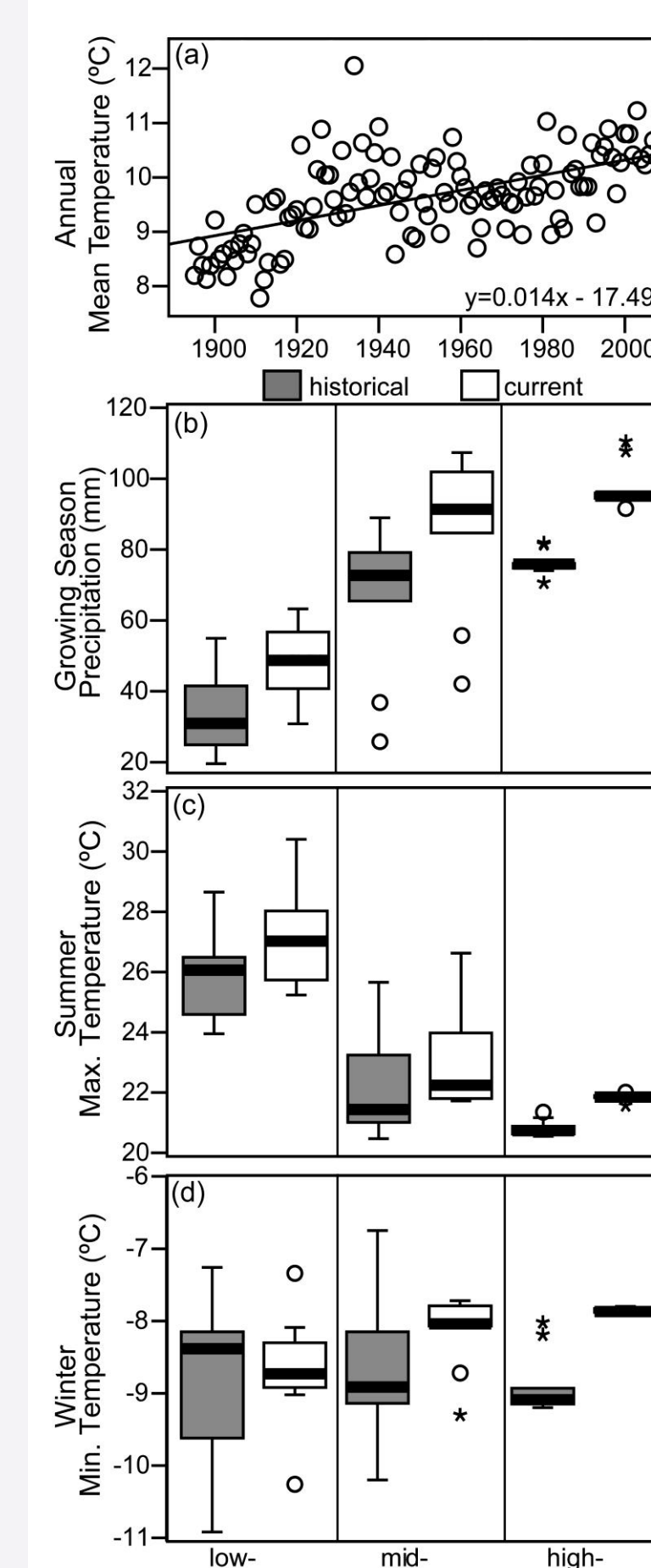
a) NEVADA STATEWIDE MEAN ANNUAL TEMPERATURE 1895-2008  
Increase of 1.11°C between surveys

HISTORICAL-MODERN COMPARISONS  
LOCALITIES, GROUPED BY ELEVATION

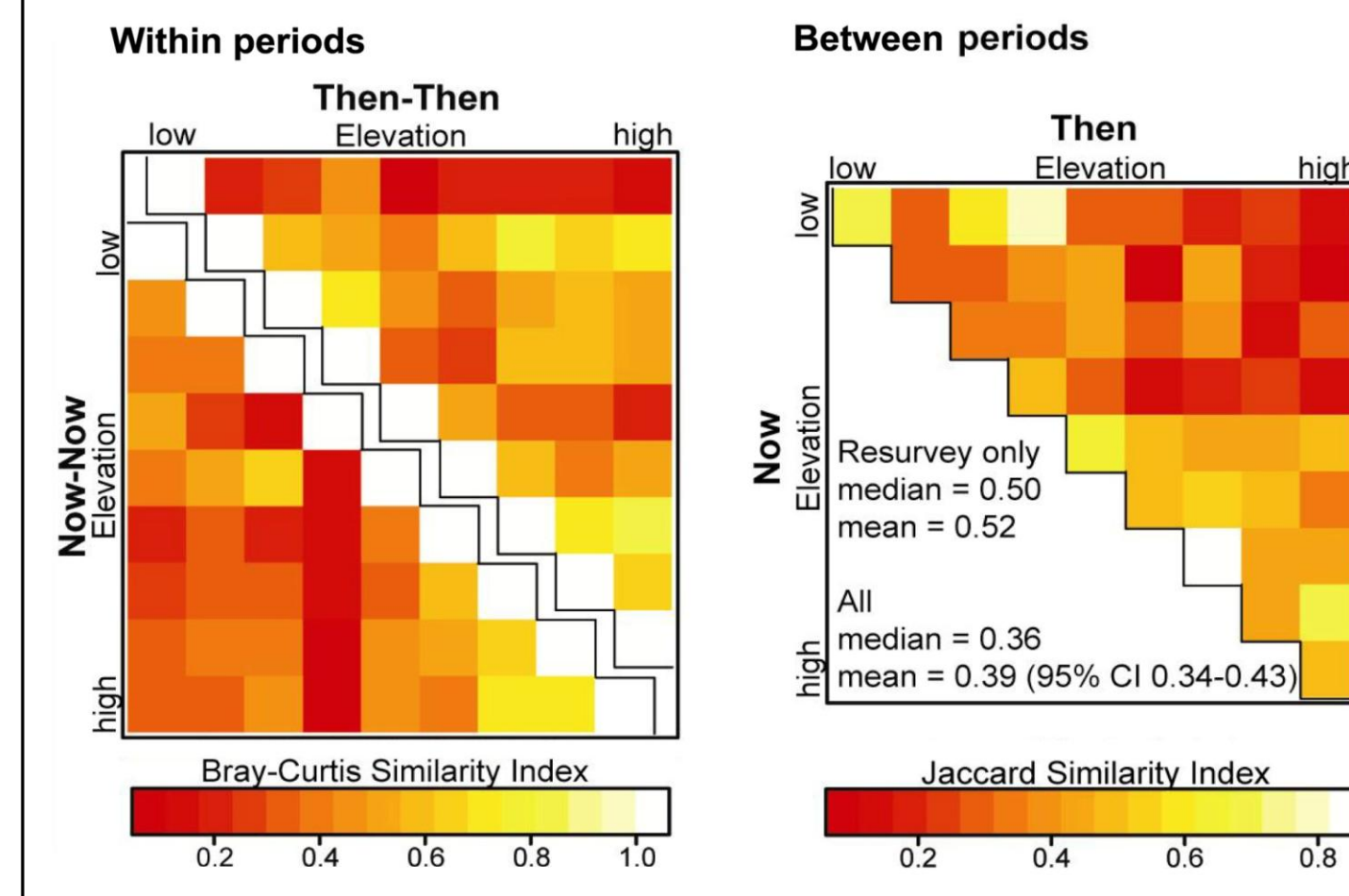
b) WINTER-SPRING PRECIPITATION  
significantly wetter across elevations

c) SUMMER MAXIMUM TEMPERATURE  
significantly warmer across elevations

d) WINTER MINIMUM TEMPERATURE  
significantly warmer at high elevations



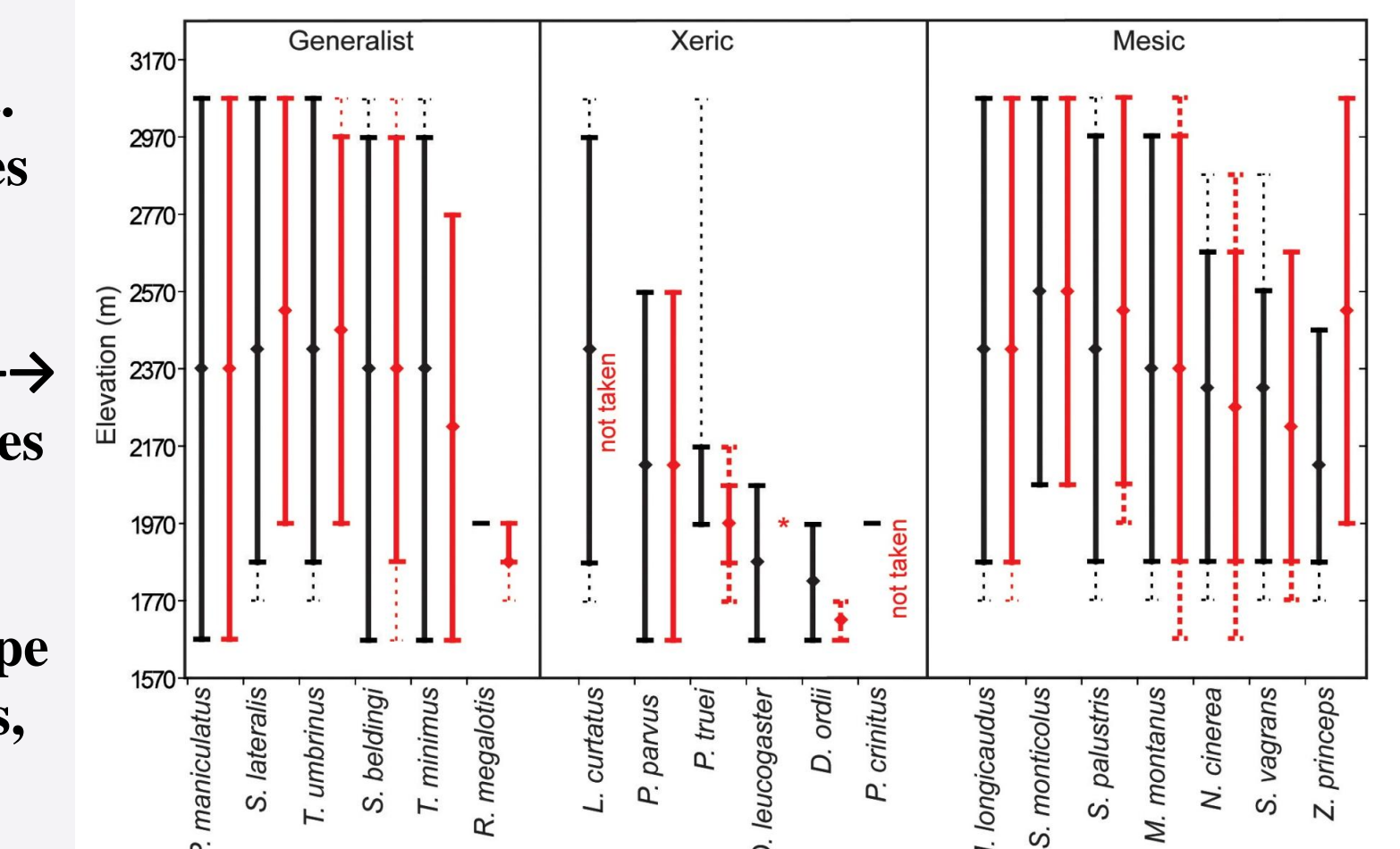
## LOCAL COMMUNITIES



← Communities are less similar now than in the past. High elevation communities more stable over time.

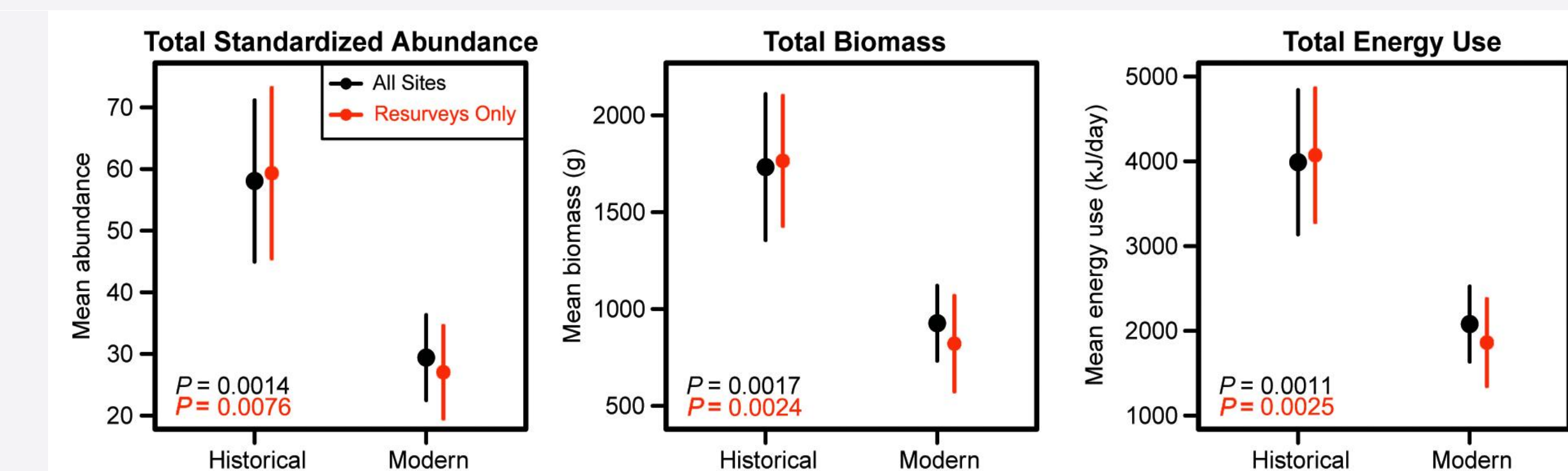
Observed & estimated → elevation ranges of species during historical (black) & current (red) periods. Disappearance or down-slope contraction of xeric species, up-slope shift for 2 mesic species

## ELEVATION DYNAMICS



## AGGREGATE COMMUNITY PROPERTIES

TOTAL SMALL MAMMAL ABUNDANCE, BIOMASS, AND ENERGY USE  
All have declined across the 80-year interval.



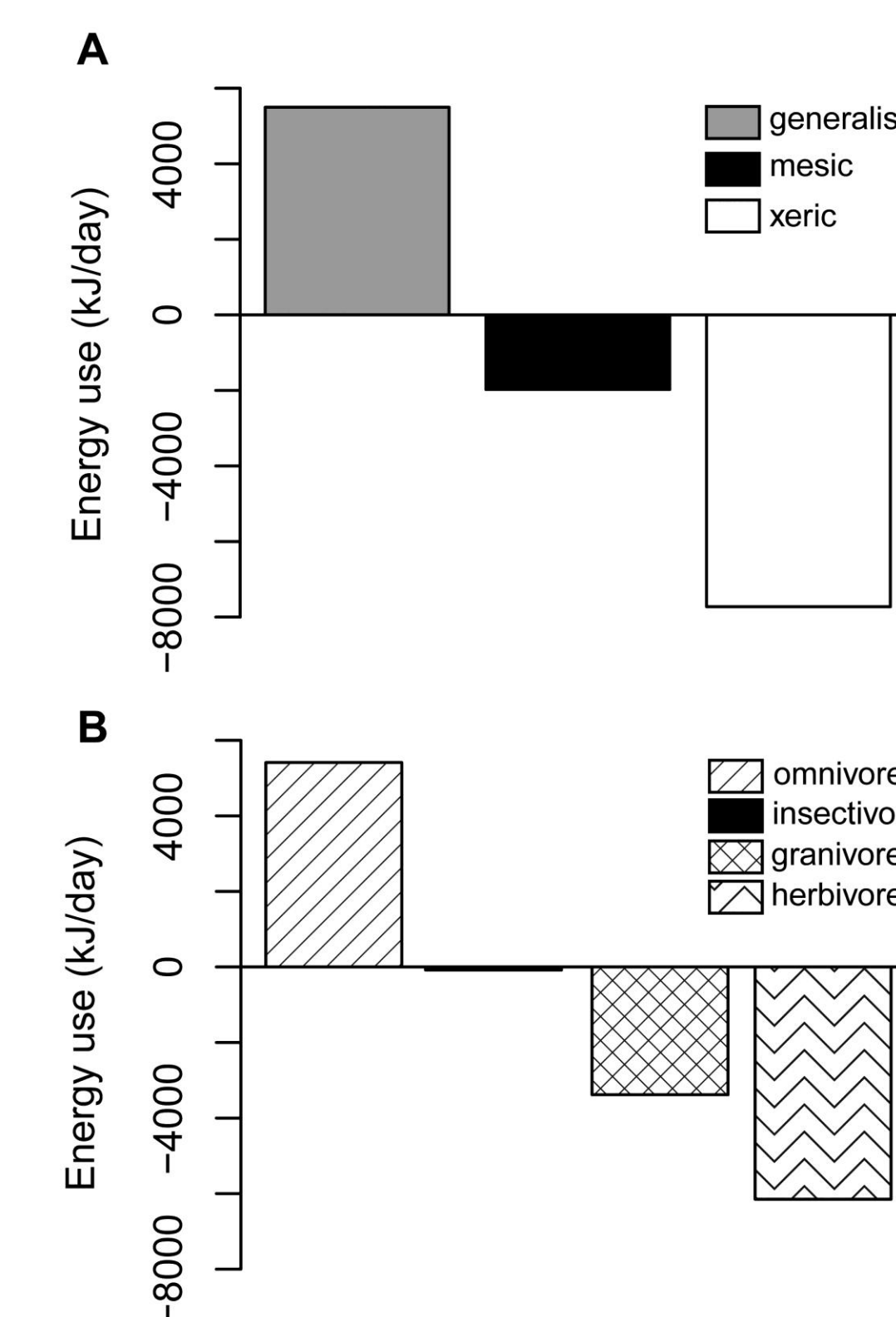
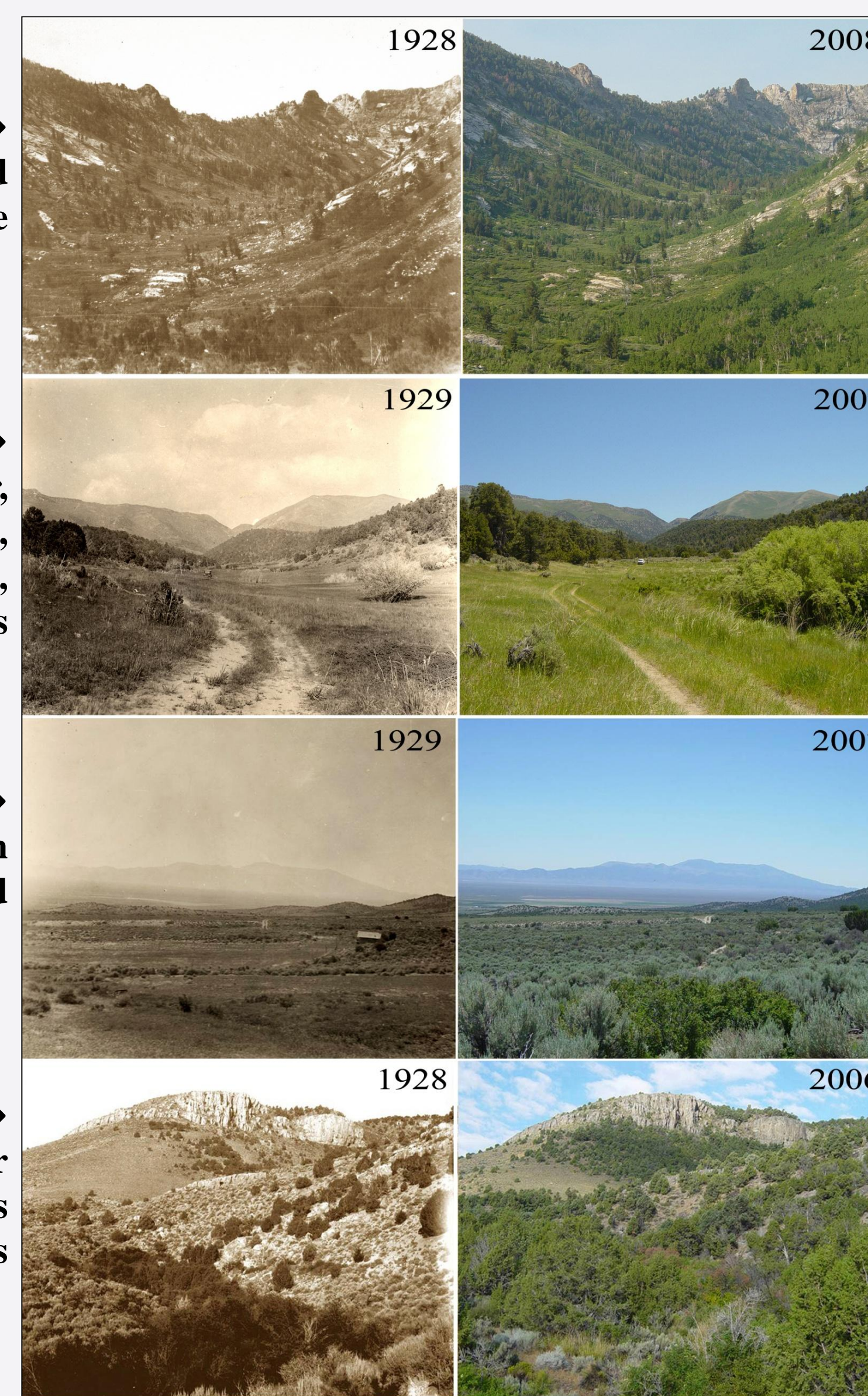
## HABITAT CHANGES

2500 m →  
Expansion of aspen and limber pine

2010 m →  
Expansion of piñon-juniper, displacement of shrubs, increased willow, grass, forbs

1980 m →  
Expansion of sagebrush into former cultivated land

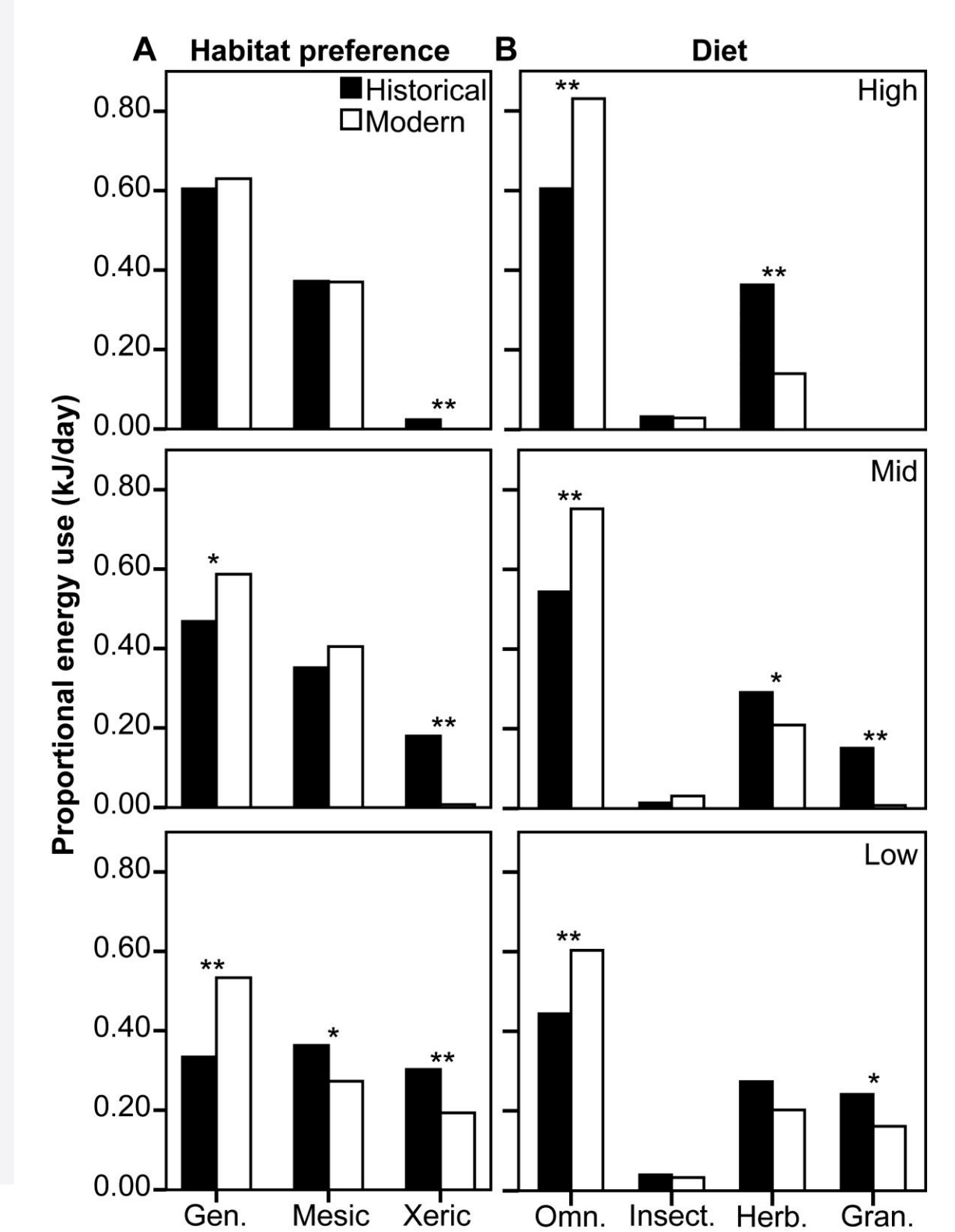
1859 m →  
Expansion of piñon-juniper  
Displacement of shrubs  
Invasion of cheatgrass



CHANGE IN ENERGY USE FOR SPECIES  
FUNCTIONAL GROUPS  
(trends for abundance & biomass are comparable)

← ABSOLUTE CHANGE  
Habitat generalists and omnivores have increased, but not enough to offset declines of habitat & dietary specialists.

PROPORTIONAL CHANGE  
ACROSS ELEVATION  
Generalists increase, specialists decline. Most significant habitat group changes at low elevation.



## CONCLUSIONS

### COMMUNITY COMPOSITION

Changes in small mammal communities were most profound at lower elevations. Some appeared to be in direct response to climate changes, others in response to vegetation changes that may have occurred due to climate, land-use, or both factors.

### LANDSCAPE SCALE PATTERNS

Mesic species decreased at low elevations, increased at mid-high elevations, and some had up-slope range shifts (consistent with predicted response to warming). Xeric species decreased overall and had down-slope shifts or range contractions (counter to climate change expectations, but consistent with vegetation changes).

### CHANGES IN COMMUNITY PROPERTIES

Abundance, biomass, and energy use have all declined over the 80-year survey interval. Declines are independent of spatial scale but are more pronounced at low elevations with greater impact on ecological specialists. These patterns appear to reflect a major decline in resource availability.

## ACKNOWLEDGMENTS

